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Microhairs of Indian *Eragrostis* (Poaceae) and their taxonomic significance

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भारतीय इराग्रोसटिस (पोएसी) के सूक्ष्म बाल एवं उनका वर्गीकरण महत्व

सी. पी. विवेक, जी. ज्ञानसेकरण, जी. वी. एस. मूर्ति एवं वी. जे. नायर

सारांश

स्कैनिंग इलेक्ट्रॉन सूक्ष्मदर्शी द्वारा भारत में 44 इराग्रोसटिस प्रजातियों के पत्ती की सतह पर सूक्ष्म बाल की आकारिकी पर किया गया अध्ययन प्रस्तुत है। सूक्ष्म बाल के तीन अलग प्रकार अर्थात कलोरिडोइड, पानिकोइड और एनिआपोगोन (मध्यवर्ती) देखे गए हैं एवं उनकी विशेषताएं सारणीबद्ध हैं।

ABSTRACT

The morphology of microhairs on leaf surfaces of 44 *Eragrostis* species from India is studied using Scanning Electron Microscope (SEM) and the results are presented. Three distinct types of microhairs have been observed viz. chloridoid, panicoid and enneapogon (intermediate) and their features are tabulated.

Keywords: *Eragrostis*, India, Leaf Surface, Microhairs

INTRODUCTION

Eragrostis is a cosmopolitan genus, largest in the subfamily Chloridoideae with about 423 species distributed in the tropical and subtropical regions of the world (Clayton & Renvoize, 1986; Veldkamp, 2002; Ingram, 2010; Giraldo-Canas & al., 2012). According to Bor (1960), there are 39 species of this genus occurring in India and Karthikeyan & al. (1989) considered this number to be 36. With the addition of recently published new species from India (Vivek & al., 2012, 2013a, 2013b & 2013c), now the total infrageneric taxa of this genus in India is 44 species and 9 varieties. Out of this total number, 5 species and 4 varieties are endemic to the country, viz. *E. ciliaris* var. *brachystachya* Boiss., *E. ciliaris* var. *clarkei* Stapf, *E. collinensis* Vivek, Murthy & V. J. Nair, *E. deccanensis* Bor, *E. jainii* Vivek, Murthy & V.J. Nair, *E. henryi* Vivek, Murthy & V. J. Nair, *E. minor* var. *rajasthanensis* Vivek, Murthy & V. J. Nair, *E. santapaui* K. G. Bhat & Nagendran, and *E. tremula* var. *gajanandii* Singh, Bala & Purohit.

Microhair is one of the significant characters of high taxonomic value in the family Poaceae. It is a specialized 2-celled trichome, commonly found on the surface of leaves but also on other parts of plants (Tateoka & al., 1959; Metcalfe, 1960). Microhair is not present in the subfamily Pooideae, however is present in all other subfamilies of Poaceae (Johnston & Watson, 1976; Watson & al., 1985). It is distributed usually on culms, upper leaf surface, lemmas, paleas and lodicules in the genus *Eragrostis*, however, few in numbers (Tateoka & al., 1959; Metcalfe, 1960), and relatively more on the lower part of the leaves. Depending on the proportional length and shape of their basal and apical cells and thickness of the cell wall, it is categorized into three types: chloridoid, panicoid and enneapogon (intermediate). Chloridoid type has short, broad and thick-walled cap cell whereas in panicoid type the

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cap cell is relatively longer, narrow and thin-walled (Plate1). The ennaepogon (intermediate) type possesses remarkably long (up to 400 μm) basal cell and elongated ovoid cap cell. The subfamily Chloridoideae is characterized by having chloridoid type of microhair (Amarasinghe & Watson, 1990). The genus *Eragrostis* belonging to this subfamily is an exception where chloridoid, panicoid and ennaepogon (intermediate) types of microhairs are seen. Chloridoid however is the most common type (Tateoka & al., 1959).

MATERIALS AND METHODS

The morphology of microhair on leaf surfaces of 44 species of *Eragrostis* from India was examined using a Scanning Electron Microscope (SEM). The mature leaves of each species were soaked in water and cut into quadrangular pieces of the size of about 0.5 cm^2. Further, their surface was cleaned with ethyl alcohol. Later, the leaves were mounted directly on stubs using double-sided adhesive tape and they were sputter-coated for 60 seconds with gold-palladium mixture in a SC7620 Sputter Coater (EMITECH). After coating, leaves were examined with a Scanning Electron Microscope (Evo M18, Carl Zeiss), using an accelerating voltage of 5 to 15 KV. Multiple micrographs and measurements were made using the Image Tool software.

RESULTS AND DISCUSSION

Out of 44 species studied for the microhair morphology of Indian *Erograstis*, 26 species were found to have chloridoid and 5 panicoid types of microhairs. In 3 species (*E. amabilis, E. ciliaris, E. jainii*) of both chloridoid and panicoid types and in another 3 species (*E. curvula, E. pilosa, E. tef*), both ennaepogon (intermediate) and chloridoid types were found within the same species. A total of 22 species were studied for their microhair morphology for the first time with SEM, which includes 6 endemic species to India: *E. collinensis*, *E. deccanensis*, *E. henryi*, *E. jainii*, *E. nilgiriensis* and *E. santapaui*. Table 1 shows the name of species and type of microhairs based on the present study and earlier published works (Amarasighe & Watson, 1990; Giraldo-Canas & al., 2012).

During the present study, majority of the species were examined using freshly collected specimens since microhairs are usually caducous in the preserved herbarium specimens. However, for a total of six species namely *E. ferruginea*, *E. lehmanniana*, *E. multicaulis*, *E. plana*, *E. subsecunda* and *E. trichodes*, the present authors could not locate any microhairs under the microscope as they were based on old herbarium specimens housed at CAL and MH. In addition, it is also noted here that these species have not been studied by the earlier workers. Therefore, they are represented as 'not seen' in the table.

Table 1. Different types of microhairs encountered in genus *Eragrostis*

NAME OF SPECIES	TYPE OF MICROHAIRS	SPECIMENS STUDIED
E. amabilis (L.) Wight & Arn.	**Chloridoid & Panicoid** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012); **Chloridoid** (present study)	*N.P. Balakrishnan* 444; *K. Subramanyam* 6905; *C. P. Vivek* 126114 (MH)
E. aspera (Jacq.) Nees	**Chloridoid** (present study)	*V. Narayanaswamy* 4516; *C.P. Vivek* 126148 (MH)
E. atrovirens (Desf.) Trin. ex Steud.	**Panicoid** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012; present study)	*K. Subramanyam* 2908 (CAL); *J.L. Ellis* 23838; *C. P. Vivek* 126154 (MH)
E. burmanica Bor	**Chloridoid** (present study)	*N.L. Bor* 15438 (CAL)
E. cilianensis (All.) Vignolo Lut. ex Janch.	**Chloridoid** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012)	*E. Vajravelu* 27574 (CAL & MH)
E. ciliaris (L.) R. Br.	**Panicoid** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012); **Chloridoid** (present study)	*B.V. Shetty* 3308; *A.R.K. Sastry* 7621 (CAL); *K.M. Sebastine* 9819 (CAL & MH)
E. ciliata (Roxb.) Nees	**Chloridoid** (present study)	*V. Narayanswami* 4597; *K.C. Jacob* 17097; *D. Daniel & S. R. Raju* 20431 (MH)
E. coarctata Stapf	**Chloridoid** (present study)	*V. Narayanaswami* 5963; *R. Chandrasekaran* 98910; *M. Mohanan* 101241 (MH)
E. collinensis Vivek, G. V. S. Murthy & V. J. Nair	**Chloridoid** (present study)	*V. Narayanaswamy* 4373; *K. Vivekananthan* 46598; *K. Vivekananthan* 42951 (MH)
E. cumingii Steud.	**Panicoid** (Amarasinghe & Watson, 1990)	*V. S. Ramachandran* 63327 (MH); *M. Mohanan* 62649 (CAL & MH)
E. curvula (Schrad.) Nees	**Intermediate** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012); **Chloridoid** (present study)	*D. Daniel Sunder Raj s.n.*, MH acc. no. 94330 & 94331; *Asst. Surgeon s.n.*, MH acc. no. 97166

NAME OF SPECIES	TYPE OF MICROHAIRS	SPECIMENS STUDIED
E. deccanensis Bor	**Chloridoid** (present study)	*K.C. Jacob* 471; *V. Narayanaswami* 3027 (MH)
E. diarrhena (Schult.) Steud.	**Chloridoid** (present study)	*M. Chandrabose* 28838; 28841; *C.P. Vivek* 126132; *C.P. Vivek* 126139 (MH)
E. diplachnoides Steud.	**Chloridoid** (present study)	*J.L. Ellis* 15754 (MH); *Hemadri* 102341 (CAL)
E. ferruginea (Thunb.) P. Beauv.	**Not seen**	*V. Komorov* 174; 2743; 4288 (CAL)
E. gangetica (Roxb.) Steud.	**Panicoid** (Giraldo-Canas & al., 2012; present study)	*K. Subramanyam* 4551; *G.V. Subbarao* 22511; *R. Ansari* 74308 (MH)
E. henryi Vivek, G. V. S. Murthy & V. J. Nair	**Chloridoid** (present study)	*A. N. Henry* 61563 (CAL & MH)
E. jainii Vivek, G. V. S. Murthy & V. J. Nair	**Panicoid & Chloridoid** (present study)	*V.S. Ramachandran* 52200; *R. Ansari* 64888; *V. S. Ramachandran* 65258 (MH)
E. japonica (Thunb.) Trin.	**Chloridoid** (present study)	*K.N. Subramanyan* 1511 (FRC); *C.P. Vivek* & *C. Kalidass* 126149 (MH)
E. lehmanniana Nees	**Not seen**	*L.H. Harvey* & *J.C. Elliott* 7293; 7318 (CAL)
E. macilenta (A. Rich.) Steud.	**Chloridoid** (present study)	*A. Pappi* 2672 (CAL)
E. maderaspatana Bor	**Chloridoid** (present study)	*K.N. Subramanyan* 899 (FRC); *V. Balasubramanyam* 1514; *S.R. Raju* 6184 (MH)
E. minor Host	**Chloridoid** (Amarasinghe & Watson, 1990; present study)	*V. Balasubramanyam* 2060; *V. Narayanaswami* 3260 (MH)
E. multicaulis Steud.	**Not seen**	*G. King* s.n., CAL acc. no. 542146; *G. King* s.n., CAL acc. no. 542148
E. nigra Nees ex Steud.	**Chloridoid** (Amarasinghe & Watson, 1990; present study)	*K.C. Jacob* 20488; *C.P. Vivek* 126135; *C.P. Vivek* 126136; *C.P. Vivek* 126155 (MH)
E. nilgiriensis Vivek, G.V.S. Murthy & V. J. Nair	**Chloridoid (**Vivek, G. V. S. Murthy & V. J. Nair, 2013)	*K. M. Sebastine* 4764; *J. S. Gamble* 20841; *C. P. Vivek* 126153 (MH)
E. nutans (Retz.) Nees ex Wight & Arn.	**Chloridoid** (present study)	*V. Balasubramanyam* 1496; *K. Subramanyam* 3809; *C. N. Mohanan* 55729 (MH)
E. pappiana Chiov.	**Chloridoid** (present study)	*Coll. ign.*, 66941 (BSI)
E. papposa (Duf.) Steud.	**Chloridoid** (present study)	*B. Krishna* 1785; *S.K. Lucksome* 2824; *D.C.S. Raju* 7321 (BSHC)
E. pilosa (L.) P. Beauv.	**Intermediate** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012); **Chloridoid** (present study)	*C.N. Mohanan* 77994; *C.P. Vivek* & *S. Arumugam* 126131; *C.P. Vivek* 126140 (MH)
E. plana Nees	**Not seen**	*K. C. Jacob* 6353 (MH)
E. riparia (Willd.) Nees	**Chloridoid** (present study)	*G. V. Subba Rao* 19584; *A. N. Henry* 47096 (CAL); *C.P. Vivek* 126122 (MH)
E. rottleri Stapf	**Not seen**	-
E. santapaui K.G. Bhat & Nagendran	**Chloridoid** (present study)	*K. Gopalakrishna Bhat* 794; *S.R. Ramesh* & *P. Prakash* 5281 (CAL)
E. schweinfurthii Chiov.	**Chloridoid** (present study)	*C.P. Vivek* 126157 (MH)
E. subsecunda (Lam.) Four.	**Not seen**	*P.V. Sreekumar* 67646 (MH)
E. superba Peyr.	**Chloridoid** (Amarasinghe & Watson, 1990; present study)	*K. Subramanyam* 3538 (MH)
E. tef (Zucc.) Trotter	**Intermediate** (Amarasinghe & Watson, 1990); **Chloridoid** (present study)	*Coll. ign.*, 13983 (MH)
E. tenuifolia (A. Rich.) Hochst. ex Steud.	**Chloridoid** (Amarasinghe & Watson, 1990; Giraldo-Canas & al., 2012; present study)	*V. S. Ramachandran* 62035; *C.P. Vivek* 126134; *C. P. Vivek* 126156 (MH)
E. tremula Hochst. ex Steud.	**Chloridoid** (present study)	*V. Narayanaswami* 4516; *G.V. Narayana* 6313; *V.S. Ramachandran* 65259 (MH)
E. trichodes (Nutt.) Wood	**Not seen**	*Le Roy H. Harvey* 8324; *Harvey* 8326 (CAL)
E. unioloides (Retz.) Nees ex Steud.	**Panicoid** (Amarasinghe & Watson, 1990; present study)	*V.J. Nair* 59957; *C. P. Vivek* 126101, 126102; *C. P. Vivek* 126142 (MH)
E. viscosa (Retz.) Trin.	**Chloridoid** (present study)	*C. P. Vivek*, 126111; *C. P. Vivek* 126150; *C. P. Vivek* 126158 (MH)
E. zeylanica Nees & Mey.	**Panicoid** (present study)	*N.P. Balakrishnan* 661 (CAL); *V. S. Ramachandran* 60035 (CAL & MH)

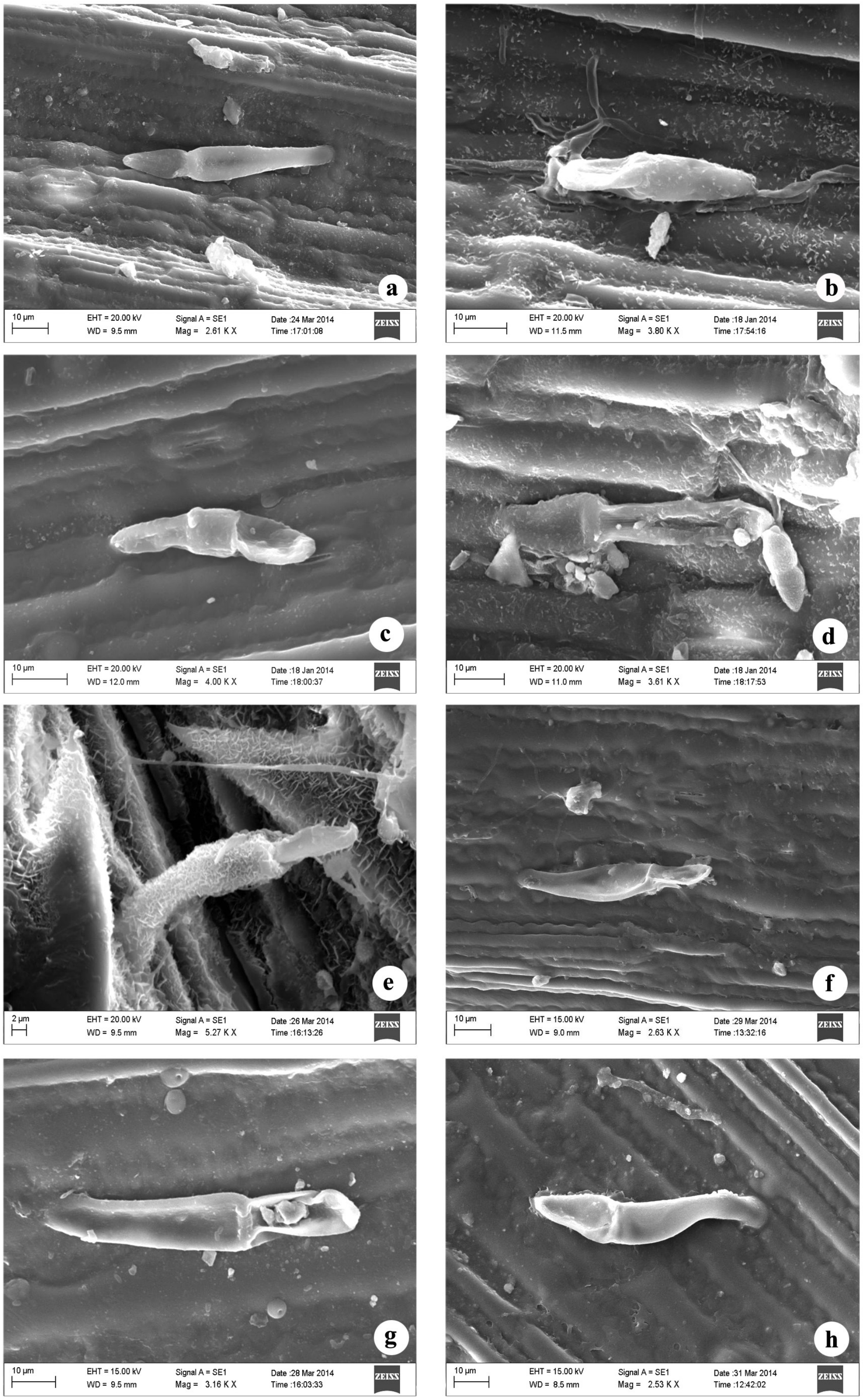

Plate 1. SEM feature of microhairs of: **a.** *Eragrostis amabilis* (L.) Wight & Arn.; **b & c.** *E. aspera* (Jacq.) Nees; **d.** *E. atrovirens* (Desf.) Trin. ex Steud.; **e.** *E. burmanica* Bor; **f.** *E. ciliaris* (L.) R.Br.; **g.** *E. ciliata* (Roxb.) Nees; **h.** *E. coarctata* Stapf.

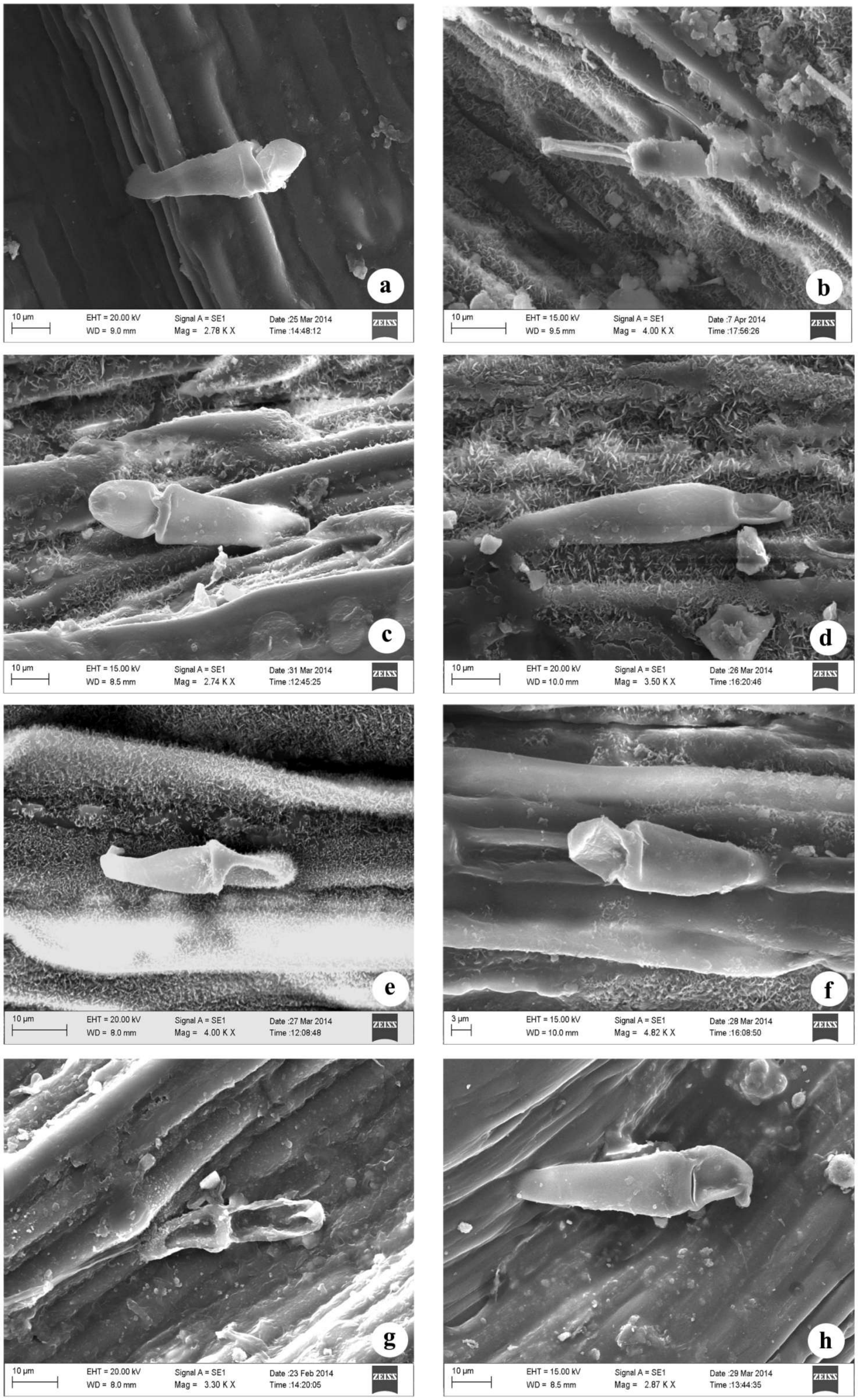

Plate 2. SEM feature of microhairs of: **a.** *E. collinensis* Vivek, G.V.S. Murthy & V.J. Nair; **b.** *E. cumingii* Steud.**;** **c.** *E. curvula* (Schrad.) Nees; **d.** *E. deccanensis* Bor*;* **e.** *E. diarrhena* (Schult.) Steud.; **f.** *E. diplachnoides* Steud.; **g.** *E. gangetica* (Roxb.) Steud.; **h.** *E. henryi* Vivek, G.V.S. Murthy & V.J. Nair.

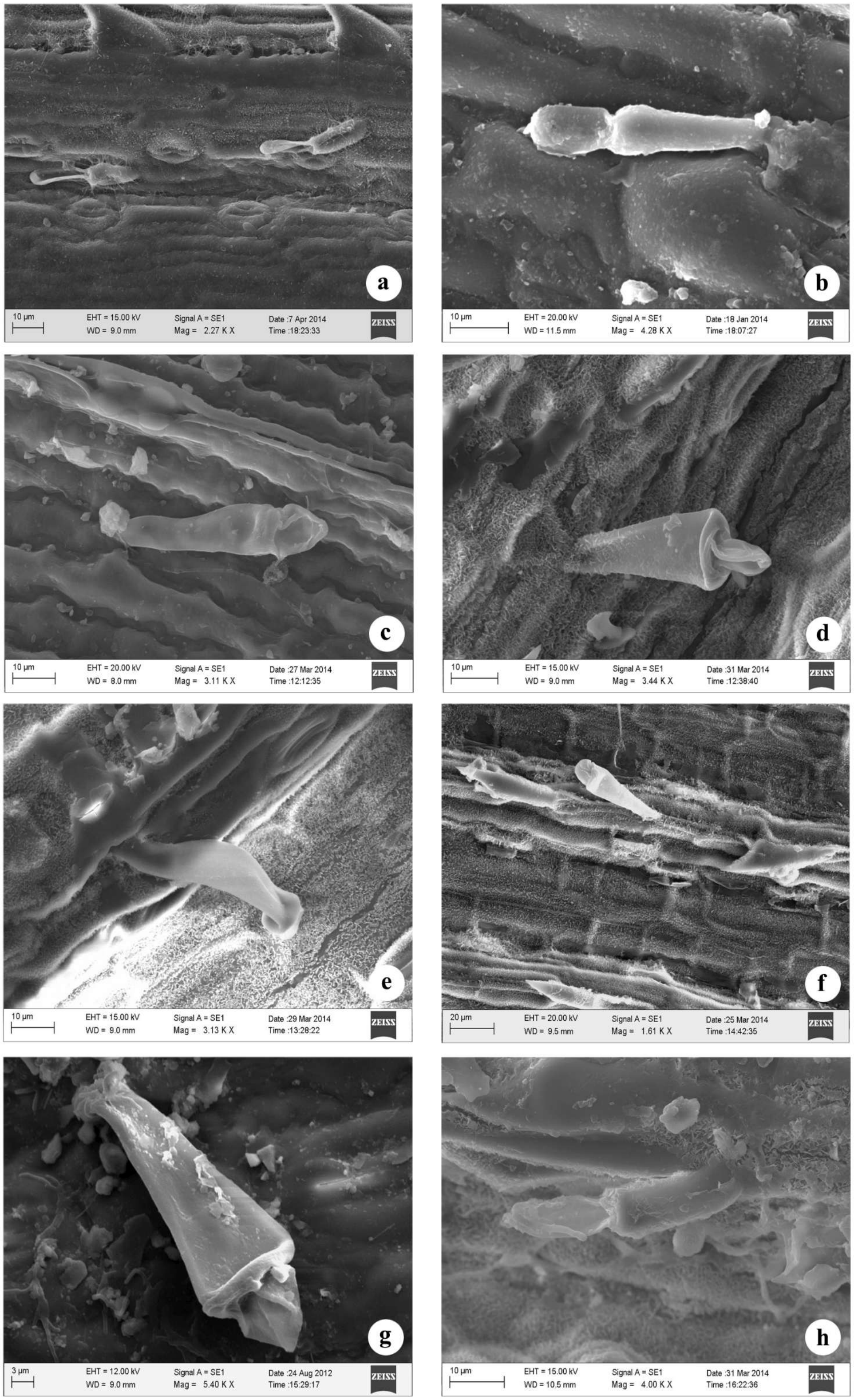

Plate 3. SEM feature of microhairs of: **a.** *E. jainii* Vivek, G.V.S. Murthy & V.J. Nair; **b.** *E. japonica* (Thunb.) Trin.; **c.** *E. macilenta* (A. Rich.) Steud.; **d.** *E. maderaspatana* Bor; **e.** *E. minor* Host; **f.** *E. nigra* Nees ex Steud.; **g.** *E. nilgiriensis* Vivek G.V.S. Murthy & V.J. Nair; **h.** *E. nutans* (Retz.) Nees ex Wight & Arn.

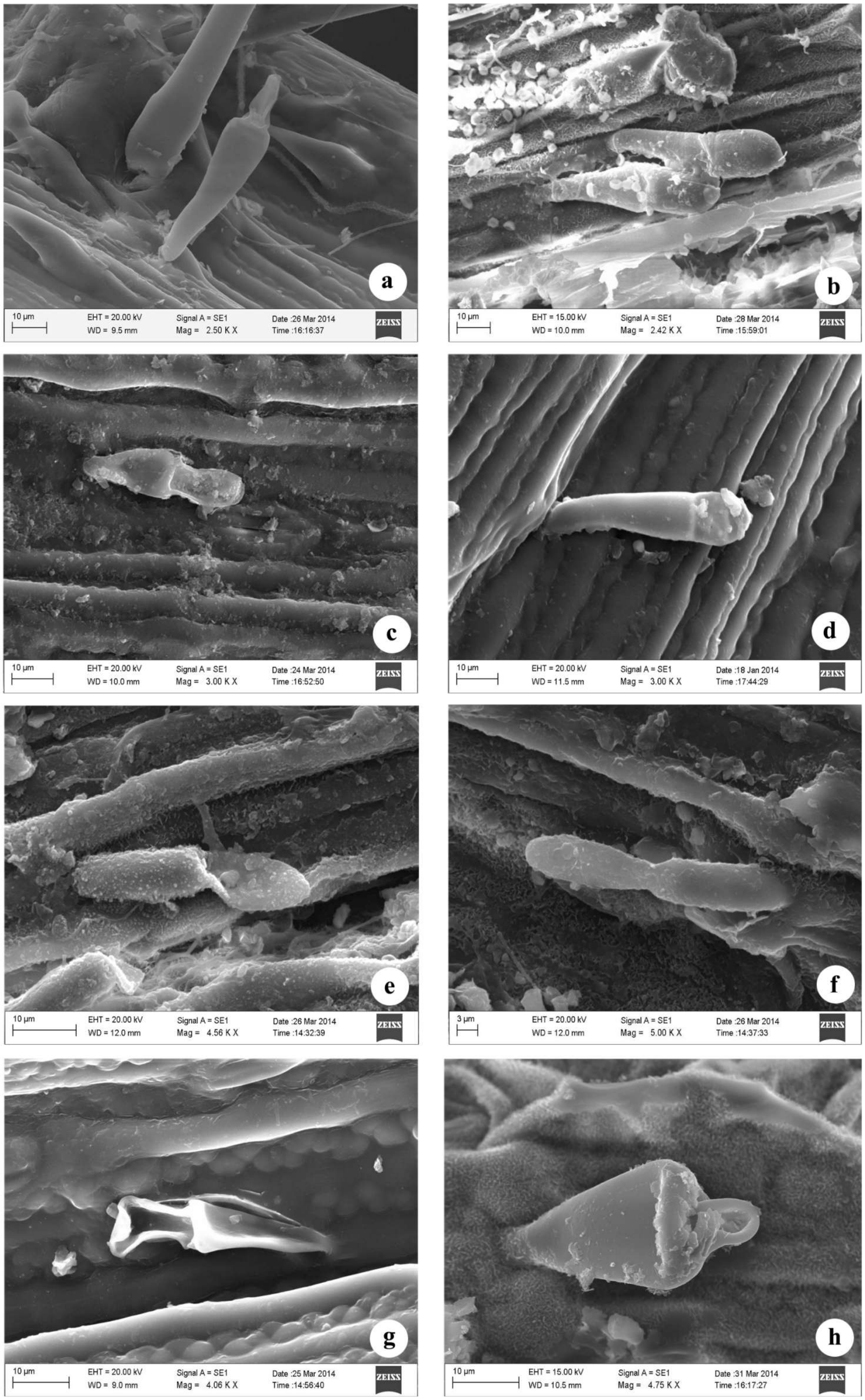

Plate 4. SEM feature of microhairs of: **a.** *E. pappiana* chiov.; **b.** *E. papposa* (Duf.) Steud.; **c.** *E. pilosa* (L.) P. Beauv.; **d.** *E. riparia* (Willd) Nees; **e** & **f.** *E. santapaui* K.G Bhat & Nagendran; **g.** *E. schweinfrthii* Chiov.; **h.** *E. superba* Peyr.

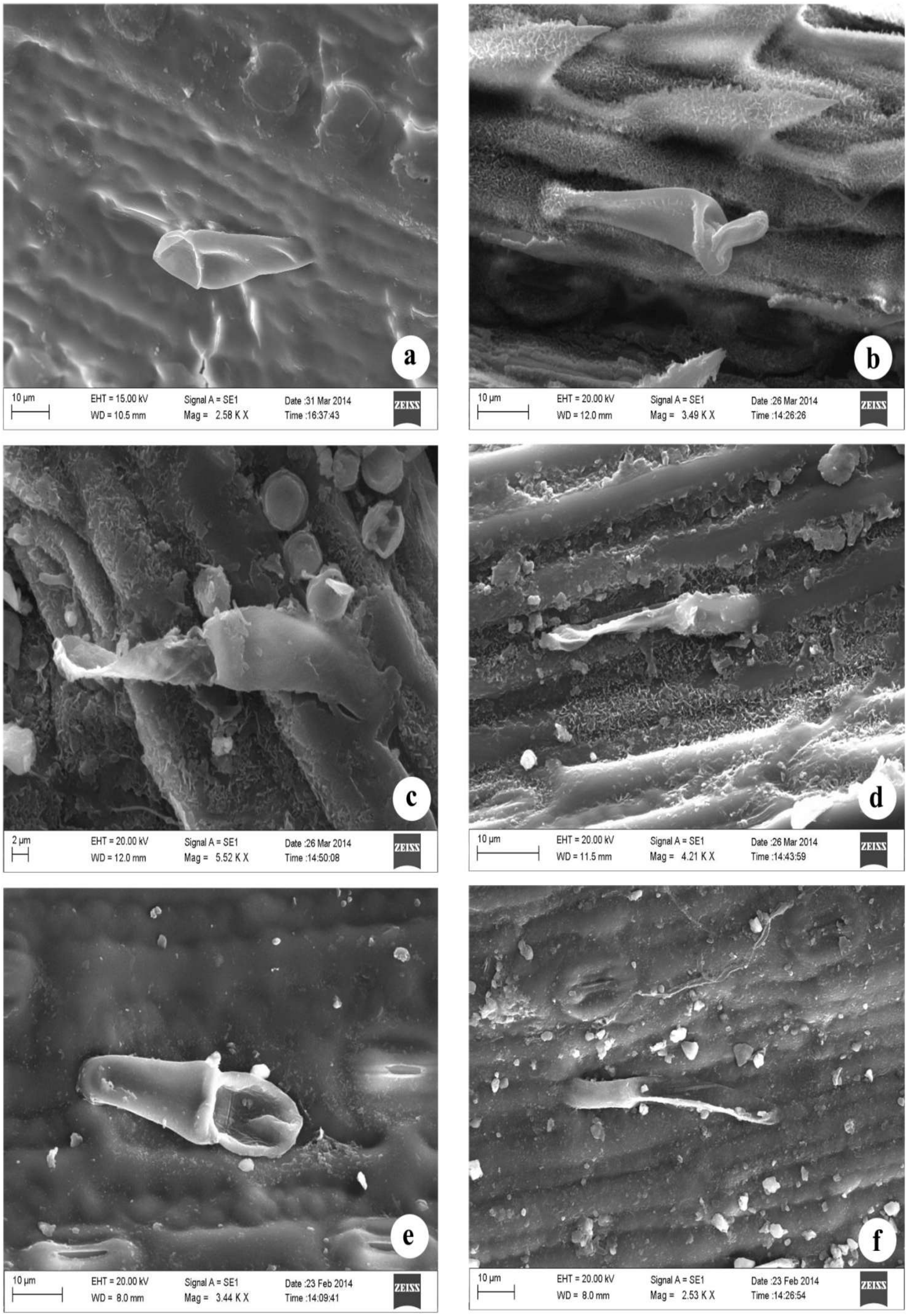

Plate 5. SEM feature of microhairs of: **a.** *E. tef* (Zucc.) Trotter; **b.** *E. tenuifolia* (A. Rich.) Hochst. ex Steud.; **c.** *E. tremula* Hochst. ex Steud.; **d.** *E. unioloides* (Retz.) Nees ex Steud.; **e.** *E. viscosa* (Retz.) Trin.; **f.** *E. zeylanica* Nees & Mey.

CONCLUSION

Though few species of *Eragrostis* were characterized by panicoid and ennaepogon (intermediate) types of microhairs, rest of them were found to have chloridoid type of microhairs. This character could be used successfully for the delimitation of species of *Eragrostis* in India when used along with other morphological characters.

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